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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1714

CORN CULTURE

CORN is the leading crop in the United States, being grown in every State in the Union on a total of nearly 100 million acres.

Because of its wide distribution it is impossible to give detailed instructions for growing a corn crop successfully. Certain general principles, however, can be laid down which will assist the individual to use methods that are suited to the immediate local conditions.

Varietal names of corn mean little. The important thing in choosing seed corn is to know that the particular strain has yielded well in the locality and that the seed has been handled so as to retain its full vigor and productiveness.

Corn grows best on fertile, well-drained, loamy soils. On poor soils plant growth may use most of the available nutrients, leaving little for the production of grain. To attempt corn growing on unproductive soils is to invite low yields with no profit.

Soils can be improved by suitable crop rotation, the growing of legumes, and the plowing under of green or barnyard manures. These practices, with the supplemental use of commercial fertilizers to supply special needs, can be relied upon to increase acre yields.

Land for corn should not be plowed when it is too wet, should not be plowed and left when excessive soil washing or blowing will result, and should be plowed thoroughly and deep enough to cover trash and vegetation. Thorough final preparation of the seed bed is important, both in promoting profitable yields and in reducing the cost of cultivation.

The principal object in cultivating corn is to control weeds. Cultivation sometimes has other advantages, but these will be provided automatically by cultivation adequate for weed control. Cultivation should be as shallow and infrequent as will control weeds. Additional cultivation is a waste.

This bulletin supersedes Farmers' Bulletin 414, Corn Cultivation.

Washington, D.C. November 1933

CORN CULTURE

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INTRODUCTION [1]

CORN PROBABLY ORIGINATED in southern Mexico, Central America, or northern South America. Certainly it was unknown to the rest of the world before the discovery of America. Now it ranks with wheat, rice, and oats in world production as one of the four leading cereal crops. About three fourths of the immense total world crop is grown in the United States, where corn is by far the most important single crop, exceeding in production and value wheat, oats, barley, rye, rice, and buckwheat combined. Corn is grown in every State in the Union, about 100 million acres of land being planted to this crop each year (fig. 1).

The concentration of dots in figure 1 shows the importance of the different areas in contributing to the total acreage in corn. Only in the Corn Belt, a somewhat indefinite area in the Central States where the concentration of dots is greatest, does any considerable part of the corn crop leave the counties in which it is produced. Even there the crop is consumed largely on the farms where it is grown, furnishing the bulk of the feed for American livestock.

The largest average acre yield of corn for the United States in any year was 31.5 bushels in 1920. In spite of this, more than 100 bushels per acre have been produced in many parts of the United States. Some large yields have been obtained by methods that are unprofitable or impractical on a large scale. Others, however, have required only such labor and expense as are entirely warranted in practical corn production. These show clearly that materially larger acre yields of corn can be had.

The distribution of the dots in figure 1 indicates also the widely diverse conditions under which corn is grown. The length of the

[1] The photograph reproduced on the title page is used by courtesy of the U.S. Army Air Service.

frost-free period, soil type, quantity and distribution of rainfall, temperature, diseases, and the insect pests differ from locality to locality. It is impossible to give detailed instructions for growing a corn crop successfully under conditions that differ so widely, not only from place to place but from day to day. Certain general principles can be laid down, however, which will assist the individual grower to follow methods suited to the immediate local conditions. The State agricultural experiment stations can make many specific recommendations as to corn-growing practices shown by careful experiments to be successful locally. Persons interested in growing corn should by all means write to the experiment station in the State

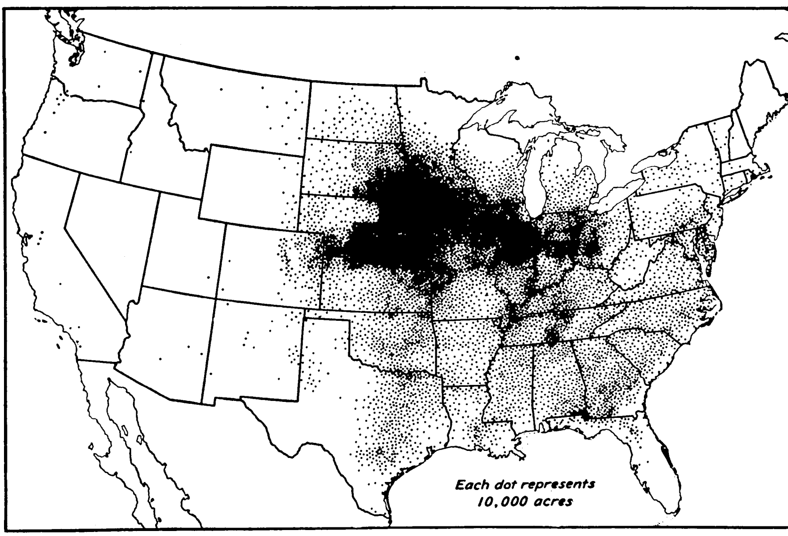

FIGURE 1.—Map showing acreage in corn in the United States, 1929. (Prepared by the Bureau of Agricultural Economics from census figures.)

in which they expect to grow the crop for its recommendations as to varieties, rotations, fertilizers, and the better local cultural practices.

SEED CORN

Even the most carefully selected varieties of corn are only hybrid mixtures and consequently are changed rapidly by selection under different conditions. For this reason a varietal name tells little about the corn except in a very general way. Thus, Reid yellow dent grown in central Iowa will require several days less to mature than the Reid grown in central Missouri. Similarly, Reid as grown in much of West Virginia is even more quickly maturing and has smaller ears. Again, selection in some States toward the so-called utility type of ear during recent years has created strains of Reid that tend to be longer eared with fewer rows of kernels and with shallower indentation than called for by the standard descriptions of Reid a few years ago. All of these strains properly are called Reid. Any two of them may differ, however, much more markedly in growth habit and yield than Reid and Johnson County white se-

lected by the same grower in the same locality. The same is true of strains of other varieties.

In choosing the kind of corn to plant, the important thing is to know that the particular strain has yielded well in the given locality or under similar soil and seasonal conditions. Most of the State agricultural experiment stations have information as to the better varieties of corn for growing in different parts of their respective States. Furthermore, this information covers strains grown in specific localities, for which reliable sources of seed can be given. Accordingly, those interested in the choice of a variety of corn should write to the agricultural experiment station in the State where they expect to grow the crop for its recommendations as to varieties and sources from which seed can be obtained.

If a reliable producer of seed of the desired variety is known, it will be better for the average farmer to obtain his seed from such a producer year after year unless he himself is willing to make the effort necessary to maintain its productivity. The methods of selecting and caring for seed corn needed to maintain its yielding power are discussed in Farmers' Bulletin 1175, Better Seed Corn, which may be purchased from the Superintendent of Documents, Washington, D.C.

THE SOIL

Other things being equal, corn grows best on fertile, well-drained, loamy soils that are neither too light nor too heavy. It is, in fact, the abundance of favorable corn soil, together with an adequate rainfall, particularly in June, July, and August, that has made the prairies of the Central States the Corn Belt. In addition to the prairie soils, well-drained bottom or second-bottom lands, if not too sandy, and the loess soils are admirably suited to corn production. Many of the Great Plains soils could produce excellent crops of corn if adequate water were available, as is shown by the very satisfactory yields obtained there when corn is grown under irrigation.

Soils that are too sandy and clay soils that are too cold and heavy for successful corn growing may be improved by a suitable crop rotation, by plowing under green-manure crops,[2] or by applying manure. The addition of organic matter in any of these ways not only increases the available fertility but also increases the moisture-holding capacity of sandy soils and lightens and increases the water-absorbing capacity of heavy soils.

Corn is a rich-land crop. It must make a considerable plant growth before any grain is formed. On poor soils vegetative growth may use most of the available nutrients, leaving little for the production of grain during the latter part of the season. Hay or pasture crops are better suited to poor soils. In these crops the entire plant is of value, and yields will be about in proportion to the productivity of the soil and season. In corn, on the other hand, a fair growth of stalk with a low yield of grain profits little. To attempt corn growing on unproductive soils is to invite low yields (fig. 2), and these, with the necessary high cost of production, can mean only losses.

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[2] See Farmers' Bulletin 1250, Green Manuring.

CROP ROTATION

Diversification with an intelligent rotation of crops is essential to a profitable, permanent agriculture. It tends to distribute labor requirements more uniformly throughout the year. This avoids large charges for extra labor during some seasons and provides profitable work for otherwise waste time during other seasons. It also distributes production risks, thereby reducing the chances of total failure. The seasonal requirements of the various crops are quite different, and conditions that may injure one may be beneficial to or not affect another. Possibly one of the greatest benefits from diversification, however, is the opportunity it provides to practice crop rotation.

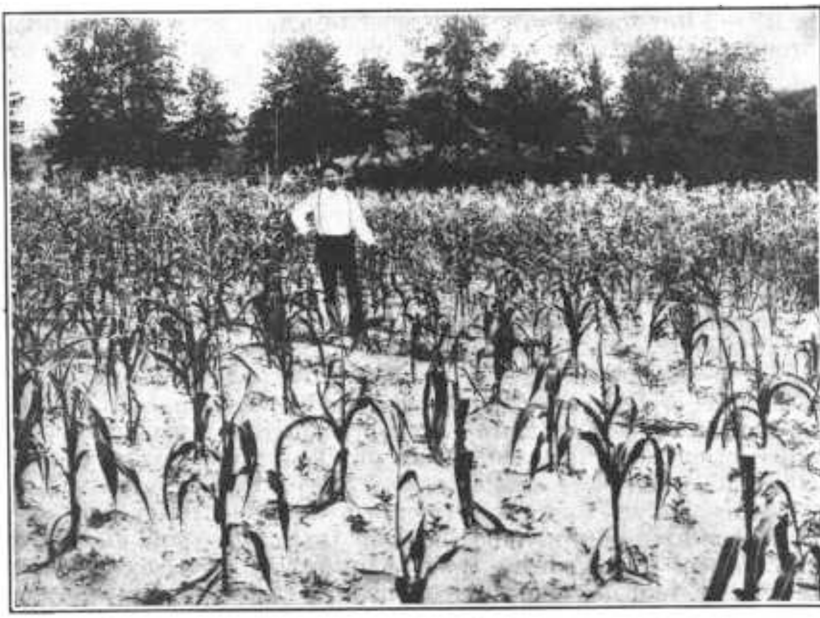

FIGURE 2.—A field in which the soil is too poor for corn growing.

Crop rotation is particularly important in successful corn growing. Because of the costs of cultivation, large acre yields must be obtained if corn production is to be profitable. A good crop rotation helps to better yields in various ways. The turning under of residues from the small-grain, hay, and pasture crops improves the physical condition of the soil and aids in equalizing the water supply of the corn crop. The decay of these residues tends to liberate otherwise unavailable nutrients. If the hay or the pasture crops are legumes, they may actually increase the nitrogen supply of the soil. Finally, a good rotation tends to prevent the accumulation of insects and diseases injurious to corn, thereby reducing losses in yield and quality from these causes.

The best rotation in any case depends upon the crops that can be grown profitably in the particular locality and the type of farm-

ing followed. Balanced farming with the feeding of a reasonable number of livestock permits the most satisfactory rotations by utilizing a maximum of hay and pasture crops. In such a system of farming much of the straw and other crop by-products may be incorporated with the manure and so converted into their most effective condition. Cash-crop production, on the other hand, frequently limits severely the choice of rotations to those suited particularly to the needs of the most important crop.

The chief rotations in the Corn Belt are a 2-year rotation of corn and small grain, a 3-year rotation of corn, small grain, and clover; a 4-year rotation of corn, corn, small grain, and clover; and a 4-year rotation of corn, oats, wheat, and clover. The small grain may be oats, wheat, or barley, and red clover or sweetclover may be used, depending upon the locality. The 2-year rotation of corn and small grain, usually oats, can be improved materially by growing sweetclover with the oats, to be turned under the following spring as a green-manure crop. The two successive crops of corn in the first 4-year rotation are more than most soils can stand unless more manure is available than usually is the case. Soybeans in place of part or all of one of the corn crops can be used advantageously where soybeans can be fed or marketed satisfactorily. The second 4-year rotation can be improved by growing sweetclover with the wheat and turning it under.

Probably no crop is more generally beneficial in preparation for corn than alfalfa. Where this crop can be grown profitably, it should by all means be used in the rotation. In some regions alfalfa may be put in and left while the other crops go through 1 or 2 complete rotations on the remaining fields. In other regions the alfalfa may be grown in the regular rotation. In drier regions alfalfa may deplete the soil moisture so much that an attempt to grow corn immediately following it frequently is a dismal failure.

Rotations similar to those used in the Corn Belt are adapted also to the surrounding regions. The proportion of corn in the rotation decreases, of course, as other crops increase in importance, and the alternating crops shift to those best adapted to the given region.

In much of the South corn ranks second only to cotton. Both are cultivated crops and do not supplement each other well in the rotation, making a somewhat similar demand upon the soil. On some of the rich alluvial soils two thirds or more of the land is used for cotton, with corn as the only other major crop. Soil fertility cannot be maintained if these crops are grown exclusively. Planting soybeans in the corn and following this with rye, winter peas, or some other crop to be turned under early in the spring will help to maintain the supply of organic matter. Larger acreages of alfalfa, such as are now being grown on some of these lands, would be highly beneficial in maintaining productivity.

GREEN MANURING

The growing and plowing under of green crops for manure will increase the productivity of most soils in any area.[3] Whether such

[3] See Farmers' Bulletin 1250, Green Manuring, and Farmers' Bulletin 1663, Winter Legumes for Green Manure in the Cotton Belt.

a practice will be profitable or not, however, will depend upon the particular circumstances. In the North, with a generally more diversified agriculture, an increase in the percentage of legumes for hay or pasture and a better conservation of crop by-products and manure frequently will be sufficient to maintain organic matter in the moderately productive soils. The second crop of clover or the last crop of alfalfa also sometimes may be turned under profitably as a green manure. Sweetclover, grown with the small-grain crop and turned under the following spring, however, probably is the most important green-manure crop in the North and is particularly useful on heavier soils.

There are several reasons why the turning under of green manure is a generally more important practice in the Southern States. The decay and consequent loss of organic matter is more rapid than in the North, and continues during the winter as well as the summer, requiring a larger replacement. The winter-grown green-manuring crop serves also as a cover crop and checks winter erosion and the loss of plant food. Finally, more different crops can be grown successfully during the winter, thus making possible selections to fit different cropping systems.

MANURE

Probably nothing will make for large yields of corn as universally as the liberal application of well-rotted manure. Such applications add both needed nutrients, especially nitrogen and potash, and organic matter, thereby increasing the absolute fertility and improving the physical condition of the soil. Within practical possibilities there appear to be no limits beyond which increased applications of manure do not increase corn yields until lack of moisture becomes the limiting factor. On the more productive soils of the Great Plains rainfall is so often deficient that manure may not increase yields enough to pay for applying it in some seasons and may even reduce yields. With a slightly greater rainfall, however, the larger amount of organic matter in manured land will aid in insuring a crop. As the available moisture increases, the value of manure and the quantity that can be used profitably increases.

Although large applications of well-rotted manure usually will increase yields more than small applications, the increase is not proportional. With the restricted supply of manure generally available, it is therefore more profitable to cover a larger acreage thinly than a small acreage with a heavy application.

Well-rotted manure may be applied to land for corn about equally well in the fall or spring unless the soil is quite sandy. On sandy soils manure should be applied in the spring to avoid undue loss from leaching. There is little difference in the effect of well-rotted manure whether plowed under or applied as a top dressing after plowing. The method that best fits in with the general operations of the particular farm accordingly can be chosen.

COMMERCIAL FERTILIZERS

Commercial fertilizers are used to supply 1 or more of the 3 most frequently deficient nutrients, nitrogen, phosphorus, and potash. They often may be used to good advantage to supply a specific defi-

ciency and to supplement the natural productivity of the soil. Corn cannot be grown profitably, however, on soil so poor that most of the nutrients used by the crop must be supplied by commercial fertilizers. The kind and amount of commercial fertilizer that can be applied profitably on any field will depend upon the original nature of the soil and the way it has been farmed previously. The best specific treatment can be determined only by actual trial. More or less haphazard experiments with fertilizers by individual farmers are likely to be costly. The recommendations of the State agricultural experiment station as to fertilizer treatments likely to prove profitable under local conditions should be obtained. The following brief general discussion is limited to fertilizers that are used most widely for corn and to those that are applied primarily to benefit the crop immediately.

Nitrogen fertilizers promote quick and vigorous growth of stalks and leaves. The nitrogen supply of the soil generally can be maintained more economically by turning under legumes such as cowpeas, clover, alfalfa, and the like. Nitrogen fertilizers, such as nitrate of soda or ammonium sulphate, sometimes may be used to advantage to supplement this supply. On thin soils and on soils that are inclined to be cold and wet, an application of nitrogen at planting time will promote a more rapid growth.

A lack of available nitrogen may be indicated by slight plant growth and by the foliage being light green or yellow-green. The presence of available nitrates is shown by a luxuriant growth of dark-green plants.

Nitrogen deficiency usually is more frequent in the South, where the longer periods of warm weather promote rapid nitrification and subsequent loss. Here it may sometimes be desirable to use some of the organic nitrogenous fertilizers, such as cottonseed meal or tankage. These become available to the plants slowly, and their effect therefore lasts during most of the season. They are expensive, however, and it is preferable to add nitrogen by applying manure and by turning under legumes.

Phosphatic fertilizers tend particularly to increase the yield of grain. Bone meal is an excellent fertilizer of this type, but its high cost ordinarily makes its use for corn production impractical. Superphosphate is the most practical form in which to apply phosphorus for immediate utilization. This may be applied after the ground is plowed and ready for planting. It may be broadcast, or applied in the row or in the hill, or both.

Extreme deficiencies of phosphorus, especially on acid soils, are indicated by stunted plants and generally unprofitable yields. Other soils may not contain enough phosphorus for maximum grain production, although containing enough for normal plant development. The only evidence of this condition is the failure to obtain grain yields in keeping with the size and vigor of the plants.

Throughout the Corn Belt, except on a few soils, lack of phosphorus is more likely to be a limiting factor in corn production than lack of either nitrogen or potash.

Potash fertilizers contribute generally to the health of the plants and quality of grain. Both muriate and sulphate of potash, containing about 50 percent of potash, are good sources. A deficiency

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of potash frequently is indicated by broken or leaning stalks and rotted roots. Peat and muck soils are especially deficient, and suitable applications of muriate or sulphate of potash to such soils, together with some superphosphate, usually will pay profitable returns. Sandy soils also are likely to require potash. Clay soils and loams are unlikely to be deficient in potash, and, if the supply of organic matter in such soils has been maintained, and particularly if reasonable quantities of unleached manure are available, such soils rarely will require additional potash.

Mixed fertilizers often may be used to advantage. It is important, however, to know that the fertilizer selected provides the elements needed for the particular case. Thus, superphosphate frequently will be profitable on land that has been well farmed and manured, where the addition of nitrogen and potash would be money wasted. On peats and mucks potash usually is the limiting factor, and the fertilizer selected should supply particularly an abundance of this element. On sandy and other light soils a complete fertilizer may be most profitable.

It should be emphasized again that nothing will do more to insure profitable yields than maintaining an abundant supply of organic matter. This will aid in making available the various nutrients already in the soil, and will assist water absorption and aeration during periods of excess rainfall and tend to check moisture losses in times of drought. Supplementing this by the intelligent application of commercial fertilizers, particularly so that they will be available at periods of special demand, will promote the most profitable yields.

APPLYING FERTILIZER

Field experiments in many parts of the country during the past few years have demonstrated that the application of commercial fertilizers in the row, or, better still, the hill, is generally more efficient than broadcast applications. Even on fairly productive soils there frequently is a period shortly after planting when the available nutrients near the young corn plants are insufficient to support the most rapid development. On less productive soils this condition is more general and more serious. The application of commercial fertilizer in the hill will get the plants off to a good start. The rapid early development of hill-fertilized corn is reflected in quicker maturity and frequently in a decidedly better crop quality in addition to any increase in yield. In dry areas, particularly on productive soils, the use of commercial fertilizers sometimes decreases yields by promoting a larger growth than the later moisture supply can support.

Fertilizers applied in the hill should not come in contact with the seed. The ideal method appears to be that in which the fertilizer is placed in a broad band on each side of the seed. Several of the commercial corn planters have been modified during recent years so that they achieve a safe and efficient placement. The essential features necessary for correct placement are (1) a deflector to spread the fertilizer stream to the two sides of the seed, and (2) a hood over the corn-planter shoe to hold back the soil until the fertilizer has reached the bottom of the furrow. Fertilizer improperly placed in the hill

may cause poor stands and actually lower yields, whereas the same amount properly placed would have been beneficial.

On reasonably productive soils that have been well-managed, it should be unnecessary to use more nitrogen or potash than can be carried in a safe hill application. It frequently will be desirable, however, to apply additional superphosphate to soils in which the nitrogen and potash supply has been maintained by manuring. If so, the additional superphosphate may be drilled in broadcast before planting, as excessive hill applications are unsafe.

PREPARING LAND FOR CORN

Except where corn is to be listed, the first step in preparation is plowing. Much has been written about the importance of this or that kind of plowing. Actually, however, there appears to be no one best way, and excellent corn crops have been produced following fall plowing, spring plowing, deeper plowing and shallower plowing, plowing preceded by disking, plowing just before planting without previous cultivation, etc. Except that land should not be plowed when it is too wet, should not be plowed and left when excessive soil washing or blowing will result, and should be plowed thoroughly and to a reasonable depth, there appear to be few absolute " dos " or " don'ts ".

Land is too wet to plow when the operation breaks down the soil structure into finer particles and puddles it (fig. 3). The effect is least damaging to sandy soils and is increasingly injurious on heavier soils. Even on sandy loams, however, wet plowing may make it impossible to put the soil in good condition for planting because of cloddiness. On clays the unfavorable effect of a single plowing when too wet may last for years. Land can be plowed somewhat wetter in the fall than in the spring. This is particularly true of sod land in the North. The roots tend to protect it from puddling, and the thorough freezing to which it is subjected tends to offset any slight puddling effect.

EROSION AND SOIL BLOWING

Plowing results in a better absorption of rainfall by loosening the soil and providing a rough surface from which the run-off is slower. Until the soil has become nearly saturated, therefore, plowing tends to reduce erosion or soil washing. After saturation is reached, however, the soft plowed soil without protecting surface vegetation is particularly subject to washing, with its attendant loss of fertility. In areas where rainfall may be expected to be heavier than the soil can absorb, there accordingly is every reason not to plow land unnecessarily long before it is to be prepared and planted. Loss by erosion is likely to be less on more level lands, less from lighter, more porous soils, and less in areas where rainfall is well distributed and not excessive. Erosion may be reduced on rolling land by terracing (fig. 4). Damage by erosion during the winter is less in the north, where the soil freezes fairly early and where much of the winter precipitation is in snow. Erosion is most serious in the South, where the winters are open and the winter rainfall relatively heavy.

Although losses from soil blowing usually are not so evident as those from erosion, they may be equally serious. The low rainfall, the light soils, and the high winds common to the Great Plains make it necessary to guard against soil blowing throughout this area. To the east, in the Corn Belt, damage from blowing tends to decrease

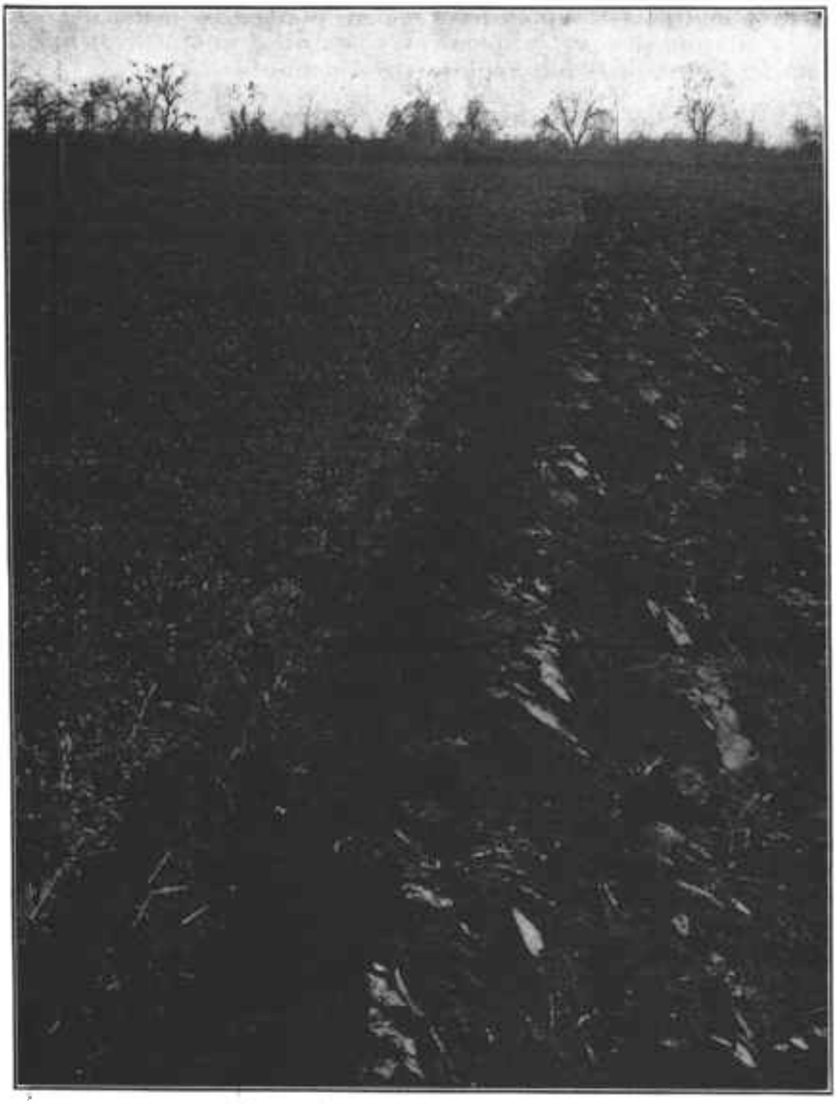

FIGURE 3.—Land in good condition for plowing.

but continues to be of importance wherever lighter soils occur. The best protection against soil blowing is to expose the bare soil surface to wind action as short a time as may be. Fall plowing of light soils therefore should be avoided except when the general system of management makes this necessary. Blowing can be reduced mate-

rially by leaving the surface as rough as possible or even definitely ridged. Thus, in the Great Plains the land may be blank listed in the fall and the ridges then broken out in the spring at planting. The use of large plows and plowing a little wet also will tend to leave the soil in a condition less subject to blowing. In general, however, the proportion of corn on soils light enough to blow badly should be small enough to make it unnecessary to fall plow.

TIME OF PLOWING

The time of plowing in preparation for corn will be determined largely by the locality, the system of farming, and the previous crop. Land that has been in a cultivated crop—corn, cotton, soybeans, potatoes, etc.—can be plowed about equally well in the fall or spring, so far as the yield of the following corn crop is concerned.

FIGURE 4.—A cultivated field in which soil washing is largely prevented by terracing.

The same is true of land in the Great Plains area that has been in small grain. The differences in yield of corn following spring plowing and fall plowing in the many experiments tried under such conditions tend to favor the spring plowing, but are too small to be important.

Fall plowing in the Southern States is undesirable because it promotes soil washing and because vegetation turned under in the fall may decay so rapidly as to be of little value to the following corn crop. Fall plowing also should be avoided on soils subject to blowing.

In the Corn Belt, where a large part of the cultivated acreage is in corn, it usually is necessary that at least part of this be fall plowed if the crop is to go in on time in the spring. In general, the fields to be fall plowed should be those that have been in alfalfa, clover, or pasture. Fall plowing these will permit the sod to break

down and settle partly during the winter and make for easier and quicker final preparation of the seed bed in the spring. The freezing of the turned soil during the winter also will help to reduce the number of insects that sometimes cause serious damage to stands of corn on sod land.

DEPTH OF PLOWING

Plowing on all soils should be deep enough to turn all surface growth under where it will remain moist and decay. This will leave a surface layer of soil free from trash to be worked down into a fine seed bed. Plowing has the added important function of loosening the soil so as to promote both aeration and better absorption of rainfall. On lighter soils this needs little consideration. Plowing deep enough to leave a clean surface will take care of it automatically. On heavier soils somewhat deeper plowing may be desirable.

Plowing less than 5 or 6 inches deep usually is insufficient to turn under surface growth and trash properly so that it will be out of the way. Plowing more than 7 or 8 inches deep, or subsoiling, usually is wasted energy. Between these limits, plowing should be somewhat deeper on heavier soils, when heavy vegetation or sod is turned under, and when done in the fall. Conversely, it may well be at the lower limits in spring plowing of lighter soils that have been in cultivated crops.

The depth of plowing generally should not be increased suddenly much beyond what it has been during previous years. Bringing more than about an inch of cold "lifeless" subsoil to the surface at once nearly always results in a poor crop, particularly on heavier soils. On some bottom-land soils and in semiarid areas this condition does not occur. Usually, however, where land has been plowed too shallow for several years it is much safer to increase the depth of plowing gradually at the rate of about an inch at a time.

FINAL PREPARATION

The final steps in preparing land for corn consist in obtaining a surface layer of some 2 inches of reasonably fine soil in which to plant, and, of even more importance, putting the entire 5 to 8 inches of soil that has been turned by plowing in the best condition to promote full development of the plants throughout their growth. This requires that the turned soil be worked down into a well-pulverized, fairly compact mass free from large air spaces either within itself or between it and the unplowed subsoil. In general, too much attention is given to having a very fine surface inch or two, and too little attention to proper preparation of the lower part of the seed bed.

The final preparation should precede planting as shortly as possible to avoid both excessive drying and the chance of rain ruining the seed bed that has been prepared. On small farms the field can be prepared and then planted immediately. On larger farms facilities usually allow the planter to follow immediately behind the last harrowing or dragging.

Land that was plowed and left in the fall frequently can be put in excellent condition simply by double disking and harrowing. Spring-plowed land sometimes can be fitted satisfactorily by similar treatment. On heavier soils, however, the use of a corrugated roller

will help to a firmer and better seed bed. The ease of fitting spring-plowed land can be increased tremendously by harrowing immediately after plowing and then waiting to finish preparation until just before planting. Harrowing the day of plowing tends to crumble the soil slightly and to prevent the furrow slice from drying out too fast and baking.

Finishing the preparation with a plank drag leaves the soil surface smooth and even for planting. It helps materially in planting to have the harrowing or dragging at an angle to the planting direction by making the marker furrow stand out more plainly.

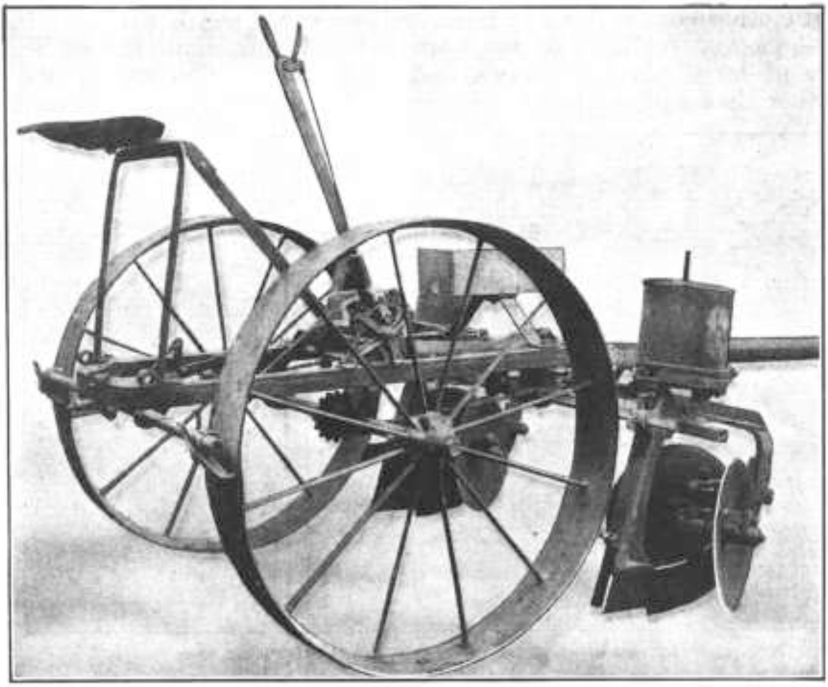

FIGURE 5.—A 2-row corn planter with disk openers for furrow planting. These can be used in drilling or checkrowing.

PLANTING CORN

Most of the corn in the Corn Belt is planted in hills in checkrows. This permits cross cultivation and the control of weeds without hand hoeing. In some areas disk furrow openers are attached to the planter so as to plant in shallow furrows and still have the corn checked in hills (fig. 5). Toward the western part of the Corn Belt and in the Great Plains listing without previous plowing is a common practice. The land is laid off in alternate ridges and furrows, the corn being planted in the bottom of the furrows either at the time of laying off (with a lister planter) or later. Listed corn usually is drilled and can be cultivated only in one direction, but the weeds in the rows can be controlled easily while the furrows are being filled during cultivation.

In some parts of the South corn is planted much as in the Corn Belt. On many of the more poorly drained soils, however, it is customary to plow the land into beds the width of a corn row and to plant in these beds. The word " listing " sometimes is applied locally in the South to this method of planting corn in the bed or " list." Throughout the South, however, some farmers here and there plant their corn in water furrows. This is essentially the same as the listing followed farther north, except that the land usually is first bedded and the corn then planted in the furrows between the beds. In the South this practice is largely, though not universally, restricted to late-planted corn.

Planting corn in hills in level, well-prepared soil is probably the best method for most of the Corn Belt. This permits the efficient use of large plows, planters, and cultivators. Planting in drills rather than hills makes for somewhat larger corn yields, owing to

FIGURE 6.—A lister planter in the Great Plains area.

the better distribution of the individually spaced plants in the drill row. The results of many experiments, however, show that this difference is unimportant even when weeds are controlled in the drilled corn. Moreover, it is practically impossible to control weeds in level-planted drilled corn in most corn soils without hoeing. Without hand hoeing to maintain equal freedom from weeds, checked corn usually will yield more than that which is drilled.

Listing corn usually results in the lowest acre cost of production. In its simplest form the land is not plowed or otherwise cultivated previous to planting. The corn is planted directly in the furrows thrown out by the lister planter, the whole operation being carried out at one time (fig. 6). In other systems the land may be broken or blank listed ahead of the actual planting. Blank listing followed by cultivation of the furrows and finally by planting tends to give the young corn plants a somewhat better start by providing a warmer seed bed. It also tends to control weeds somewhat better by killing

those that have started between the time of listing and the time of planting.

In addition to the advantage of easier weed control, listing corn achieves two very definite objectives. It tends to retard the early development, thereby making the plant less susceptible to injury from drought later on. Listing also puts the main root system of the corn plant several inches deeper than it would be with level planting, and the somewhat thicker layer of soil above this main root system then can be cultivated with less injury to the roots (fig. 7).

The slower development of the young plants in listed corn makes the method unsatisfactory for those areas in which the frost-free period is relatively short and every day of the growing season must be utilized if satisfactory yields are to be obtained. In such areas, blank listing followed by cultivation of the furrow bottoms to warm the seed bed and give the corn a better start could be utilized to

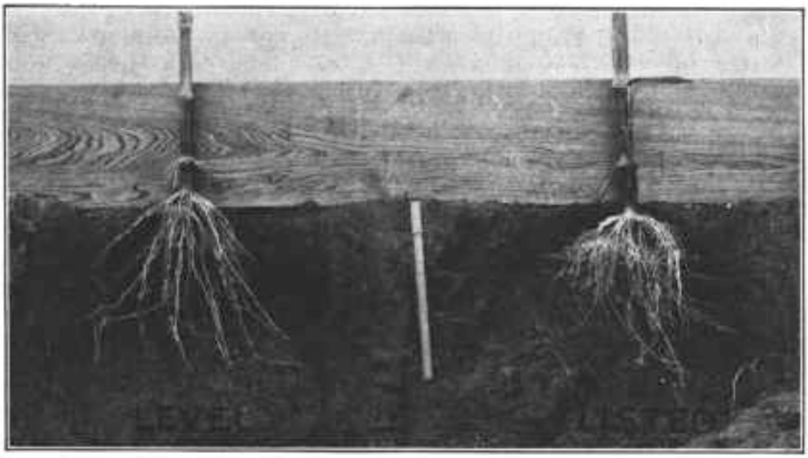

FIGURE 7.—The depth of rooting in level-planted (left) and in listed (right) corn.

eliminate in part this undesirable checking of early development. This, however, does away with those advantages of listed corn which come from the low cost of the method and the slow early development. Listing corn probably is most advantageous on lighter soils in districts where a shortage of moisture is likely to occur during the later part of the season. Thus, in the drier sections of the Great Plains area, or elsewhere on soils of somewhat similar type, listed corn may be expected to yield more than level-planted corn.

Throughout much of the Cotton Belt a deficiency in rainfall during July and August, just when the corn plants are making their heaviest demands, frequently is the major factor limiting corn production. Where the soil is not too cold and heavy, and there is reasonable drainage, listing may be advantageous. On the lighter alluvial soils of this region listing offers particular possibilities.

Planting with furrow openers combines some of the advantages of listing and level planting. It may be practiced on soils that are too heavy or too poorly drained to make listing satisfactory. At the

same time the roots are placed slightly deeper in the soil, and the small weeds in the rows can be controlled somewhat better than with level-planted corn. Corn is planted with furrow openers, however, only on prepared land, so that the cost is as great as for ordinary level planting. Moreover, it cannot be harrowed or gone over with the rotary hoe or weeder as satisfactorily as that which is level planted. Except where a real advantage in yield has been shown for this method, therefore, it is questionable whether it can be recommended.

Corn planted in elevated beds wide enough for a single row rarely produces satisfactory yields. It should be used only on poorly drained land where it is necessary to have frequent water furrows if the seed is to germinate. Even in such areas, however, lack of water during some period of the growing season usually is the factor limiting yield. Corn grown on these narrow beds can be cultivated only with severe damage to the roots. It is in an ideal position, therefore, to suffer most from lack of moisture later on. Where it is necessary to "bed up" in order to obtain stands of corn, the beds may be made wide enough to accommodate two or more rows with the water furrows between beds (fig. 8). The corn then can be planted in shallow furrows on top of the beds. The deeper rooting

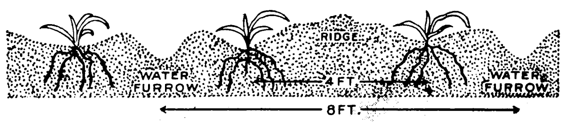

FIGURE 8.—Diagram showing a method for planting corn on low wet ground.

obtained in this way will permit the beds to be worked down during cultivation without damage, leaving the land nearly level at the last cultivation.

TIME OF PLANTING

Corn planting begins in southern Texas, usually before February 1, and progresses northward through the eastern two thirds of the United States at an average rate of about 13 miles a day (fig. 9). Planting is relatively somewhat earlier in the central part of this area, being delayed toward the west by higher elevations and toward the east by heavier, colder, and wetter soils. In the western third of the United States the date when planting begins is determined so largely by elevation that the dates for given locations can be indicated only.

Planting becomes general in from 1 to 2 weeks after the beginning dates indicated in figure 9, and is almost completed by from 3 to 4 weeks after these dates. The spread between the beginning and ending of planting is least in the extreme north and becomes wider toward the south. In much of the Cotton Belt there are two more or less distinct corn-planting periods. The first, for which dates are shown in figure 9, begins before and continues partly with cotton planting. The second and less important period begins about June, after the cotton has been planted and chopped.

The best time to plant corn usually will be as soon after the beginning date indicated above as the soil is in good condition for plant-

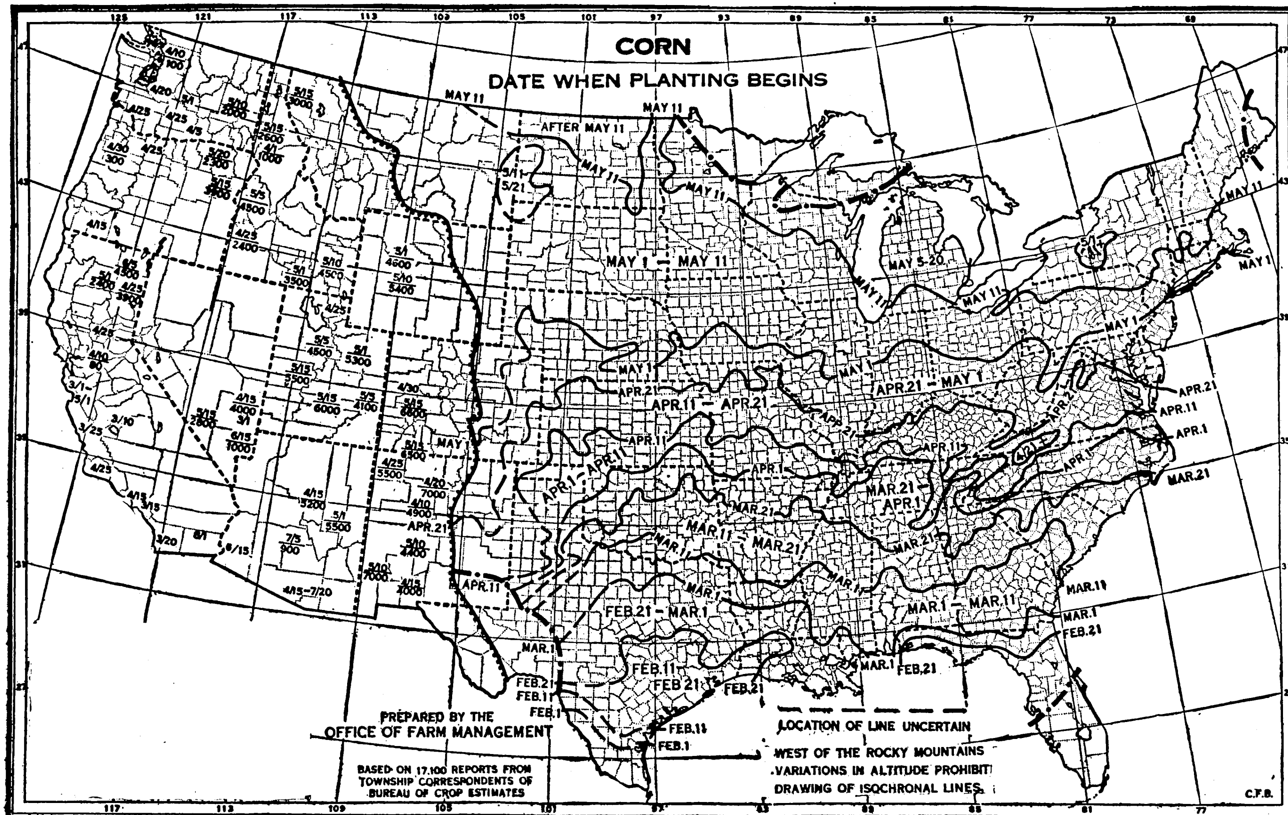

FIGURE 9.—Map showing dates on which corn planting begins.

ing and the weather is fit. The dates indicated are averages, and in late springs temperatures lower than normal make it advisable to delay planting. Similarly, it is futile to plant corn early in a cold, poorly prepared seed bed. The seeds will not germinate well under such conditions, and many will rot. The result is a poor stand, with no gain in advancement over a somewhat later planting when conditions for germination and growth have become more favorable.

Corn can be planted somewhat earlier on lighter or sandier soils than on the colder clays, and earlier on more productive than on less productive soils. Application of commercial fertilizer in the hill at planting will promote early growth and partly offset unfavorable conditions that often prevail when corn is planted early. Where planting has been delayed unduly because of cold or wet a similar application may increase the rapidity of development enough to make up for the loss.

RATE OF PLANTING

The rate of planting corn should be adjusted to the size of the plants and the productivity of the soil. The rank-growing, long-season varieties adapted to the Southern States will not stand nearly so thick planting as do the smaller varieties of the North. In the Great Plains area the frequent lack of moisture when corn needs it the most requires thinner planting in spite of the productive soil. Soils capable of producing 80 bushels per acre will make their best yields, with perhaps a 50 percent thicker stand than will adjacent fields capable of producing only 40 bushels.

As a result of 5 years' experiments the Illinois Agricultural Experiment Station recommended planting 3 kernels per hill in hills 3 feet apart each way for Corn Belt soil in northern Illinois. For central Illinois the station recommended 3 kernels per hill in hills 3.3 feet apart for soils capable of producing acre yields of more than 50 bushels, and 2 kernels per hill in hills 3 feet apart for less productive soil.

In Iowa larger average yields for a 5-year period were obtained in the northern half of the State from planting 5 kernels per hill than from planting 4, 3, or 2 kernels. In the south-central fourth of the State the largest yield was obtained from planting 4 kernels per hill, and in the southern fourth of the State from planting 3 kernels. Varieties adapted to each section were used, and the average yield for the best rate in the four sections ranged only from 61 to 67 bushels. The superiority of the thinner rate in the southern part of the State was a reflection of the larger size of the varieties grown there. The data on final stand from planting at these different rates show that only about 75 percent of the kernels planted at the rate of 4 and 5 kernels per hill as compared with 80 and 84 percent of those planted at the rate of 3 and 2 kernels per hill were represented by plants at harvest. The actual final stands accordingly were 1.7, 2.4, 3.0, and 3.7 plants per hill from planting 2, 3, 4, and 5 kernels.

In Minnesota, planting 3 or 4 kernels per hill in 44-inch check-rows produced about equal yields, which were larger than those obtained by planting either 2 or 5. The 3-kernel rate produced a larger proportion of marketable corn. In Ohio larger yields were obtained over a 10-year period from planting 4 kernels in hills 3.5 feet apart each way than from planting either fewer or more. The

4-kernel rate produced smaller ears and more nubbins than the 3-kernel rate, and the stover was finer. Comparisons in Arkansas extending over 4 years showed larger yields from stands equivalent to about 2½ and 3 plants per hill in rows 44 inches apart for corn grown under favorable conditions and from somewhat thinner stands under less favorable conditions. In eastern Kansas experiments with drilled corn on creek-bottom land favored spacing the plants 16 inches apart in the row, as compared with 12, 20, 24, 28, and 32 inch spacing. On upland, the largest yields were from 20 and 24 inch spacings. In both experiments, however, there was little difference between the corn spaced 16, 20, and 24 inches apart, although the

FIGURE 10.—Widely spaced corn rows with cowpeas in the middles.

stand at the 16-inch spacing was 50 percent thicker than that at the 24-inch spacing.

In contrast to these relatively thick rates, the Georgia Agricultural Experiment Station concluded that on upland soil capable of producing acre yields of from 35 to 40 bushels, rows 4 feet apart with plants spaced 2 to 2½ feet in the row would produce the largest yields, and that on thinner soils the spacing should be greater (fig. 10).

In most of the experiments on rate of planting, the yields from 2 or even 3 rates have been so close together that the differences were unimportant. In such cases the decision as to the rate to use should depend upon other considerations. In general, the thinner of two rates yielding approximately equally over a period of years may be

expected to yield more than the thicker in the less favorable seasons, and particularly so under extreme conditions. Corn planted at the thinner rate also will produce larger ears, have fewer barren plants, and tend to lodge less than that planted more thickly, with a consequent lower cost for husking.

DEPTH OF PLANTING

Corn should be planted deep enough to put the seed in moist soil where it will not be in danger of drying out. In soils that tend to be cold, an inch or an inch and a half is deep enough. On sandy soils, where the surface is drier, it may be necessary to plant 3 inches deep or, rarely, even more. It is particularly important not to plant corn any deeper than need be early in the season. At that time the soil is less likely to dry out around the seed, making deep planting unnecessary, and the higher temperatures near the surface will favor more rapid germination and vigorous growth.

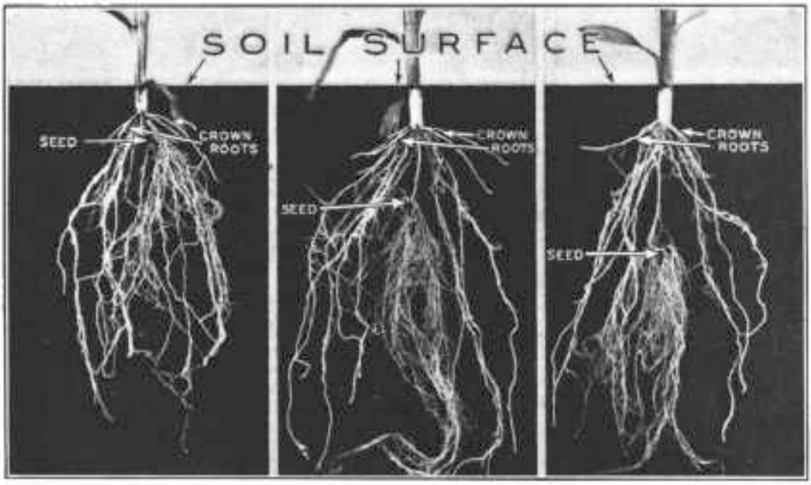

FIGURE 11.—Depth of planting corn has little effect on the depth of the crown roots.

It sometimes has been thought that deeper planting would result in deeper rooting. It is the crown roots, however, on which the corn plant depends during its later growth. These develop just a little below the surface of the soil, regardless, within practical limits, of the depth of planting, as shown in figure 11.

CULTIVATION

The object of cultivation frequently has been stated as being (1) to control weeds, (2) to increase absorption by reducing run-off, (3) to check evaporation by maintaining a mulch, and (4) to increase aeration of the soil. Undoubtedly cultivation performs all of these functions under certain conditions, but it seems equally certain that the one all-important reason for cultivating corn usually is to control weeds.

The importance of maintaining a dust mulch formerly was stressed as a means of preventing evaporation from the soil surface. The soil in a cornfield, however, is so filled with corn roots that almost

no moisture can come up past them to reach the surface unless there is an excess present. Cultivating this root-filled soil does practically nothing to save needed moisture and at the same time injures the roots of the corn plants to a greater or less extent, depending on how it is done and on other conditions (fig. 12). The roots of weeds come into direct competition with those of the corn plants for both moisture and nutrients. It therefore is essential that weeds be controlled.

Hundreds of experiments have been conducted by the State agricultural experiment stations and by the United States Department of Agriculture in which have been compared the yields of corn from cultivated plots and from plots from which the weeds have been scraped with a hoe without disturbing the soil any more than necessary. In most of these comparisons the difference in yield has been negligible, sometimes one method being slightly better and sometimes the other, clearly indicating no particular difference. In a few experiments distinctly better results were obtained by cultivating and in a few by scraping.

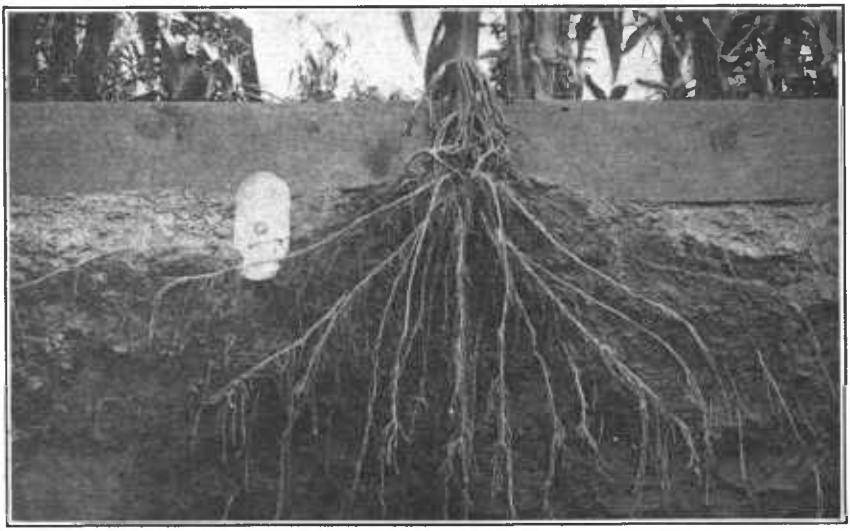

FIGURE 12.—Corn roots as they grow. The bottom of the board rests on the soil surface, and the cultivator shovel shows how deep cultivation injures the roots.

There also have been extensive experiments on the merits of deep and shallow cultivation. In some of these shallow cultivating has been superior to deep cultivating, but in none has there been any important difference in favor of deep cultivation. Other experiments have failed to show any benefit from unusually frequent cultivation or from unusually late cultivation. The results of all the experiments considered as a whole indicate that cultivating as often and as deep as is necessary to control weeds, and no more, is the desirable practice.

IMPORTANCE OF EARLY CULTIVATION

Weeds can be killed most easily and cheaply when the field is being prepared for planting and before the corn is up or while it is small

enough to stand harrowing without injury. At such times the land can be gone over quickly with the harrow, weeder, or rotary hoe. These implements are highly efficient in controlling weeds if used before the latter become established, and they hold down the cost of cultivation.

Harrowing from just before to just after the corn seedlings emerge should be avoided unless it is essential. At this stage the young plants are very brittle and those broken below the surface have difficulty in emerging. The soil sometimes may crust after beating rains to such an extent that the value of breaking the crust may offset possible damage to the seedlings. Such occasions, however, are rare. After the plants are well up they may be harrowed with little damage until they are some 4 inches high. Less injury will be done by

FIGURE 13.—A corn cultivator equipped with narrow shovels and fenders for early cultivation.

harrowing in the late mornings and afternoons than in the early mornings when the plants are more tender.

LATER CULTIVATIONS

Later cultivations can be made satisfactorily with any of the usual cultivators. While the plants are very small, narrow shovels that throw the soil but little should be used, and fenders usually are desirable to prevent covering or injuring the corn (fig. 13). The same equipment without the fenders can be used for subsequent cultivations, or wider shovels (fig. 14) or surface cultivators (fig. 15) can be used, depending upon local conditions.

Corn should be cultivated often enough to control weeds. More cultivation accordingly will be required in seasons of frequent rainfall. With weeds controlled, additional cultivation is a waste.

In general, cultivation should be no deeper than needed to control weeds. Shallow cultivation is less likely to injure the corn roots (fig. 12) and does not bring many weed seeds to the surface.

Corn can be cultivated most efficiently as soon after rains as the soil is dry enough to work well. At this time the newly germinating

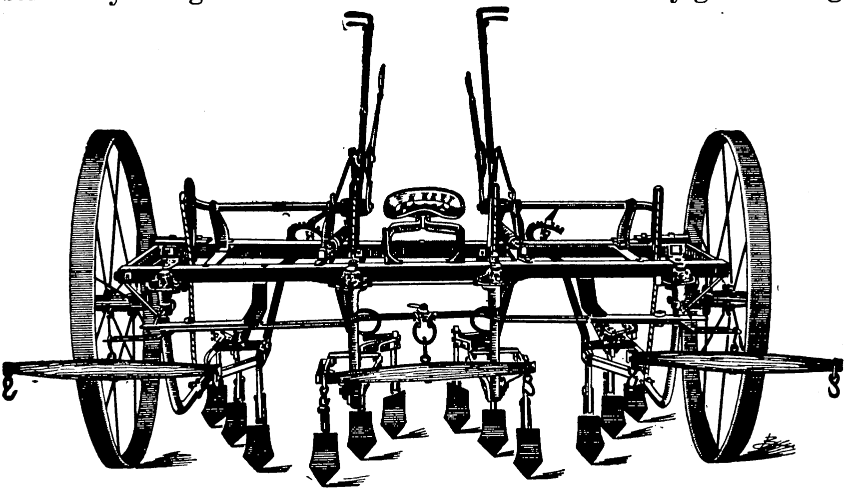

FIGURE 14.—One kind of 2-row cultivator.

weeds are killed most easily and the soil is left in the best physical condition. Corn should not be cultivated when the soil is so wet that puddling may result.

CULTIVATING LISTED CORN

One of the objects of listing corn is to obtain deeper rooting of the plants (fig. 7). This can be accomplished only if the furrows are kept open until the crown roots are established (fig. 11). A 2-row lister-cultivator used in the first cultivation of listed corn is shown in figure 16. The disks in this case are set to cultivate the sides of the furrows without pulling the soil down into them. The second cultivation may be given with the same implement set to fill the furrows partly, or with any of the ordinary cultivators. Ordinary cultivators are used for the third and any necessary subsequent cultivations, the furrows being filled during the third cultivation.

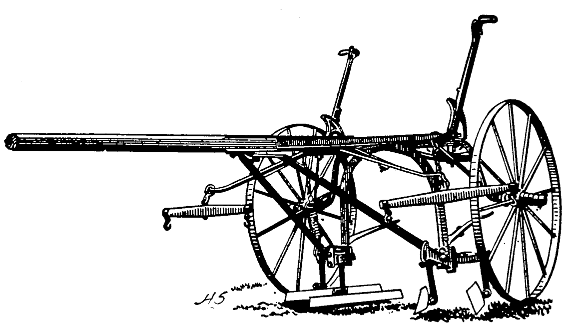

FIGURE 15.—A double cultivator equipped for surface cultivation.

ECONOMY IN CULTIVATING

Mention already has been made of the desirability of utilizing large tools in the early cultivations. This permits covering the

whole field more quickly and reduces the labor cost. Thus, under conditions similar to those in central Illinois, one man with 4 horses can harrow from 25 to 30 acres in a 10-hour day, whereas he can cover only about 15 acres with a 2-row riding cultivator in the same time. With 2 horses and a 1-row riding cultivator only 7 to 8 acres can be covered in 10 hours, or about one half of what can be done with a 2-row riding cultivator and 4 horses.

Large tools cannot be used under all conditions. Insofar as they can be used efficiently, however, they will do much to reduce the cost of production. In the first place, they eliminate labor otherwise necessary for the particular operation. In addition, they frequently permit completing the operation while it is most timely and effective and thereby eliminate the need for additional labor at some future time.

The largest item in the cost of corn growing is labor, and it is in this item that reduction in production costs must be made. No formula can be given as to just when a farmer should plow, disk,

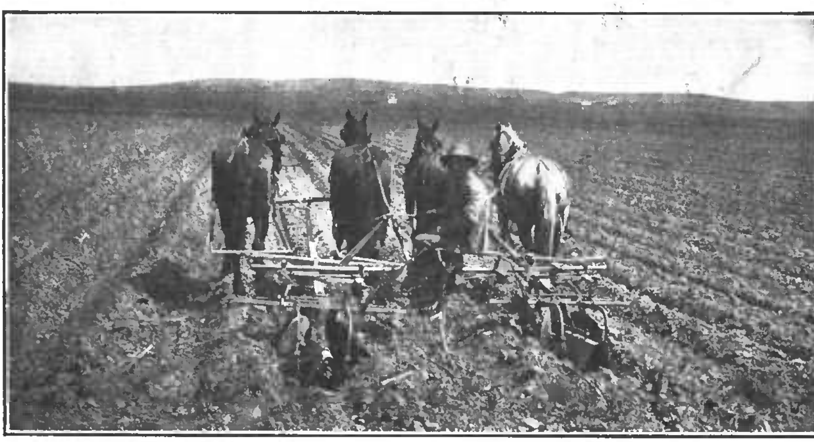

FIGURE 16.—The first cultivation of listed corn. The row at the driver's feet will be cultivated on the return trip.

harrow, or cultivate in order to keep down the cost. The soundness of judgment of the individual farmer in determining the proper time for these operations, however, will do much to eliminate unnecessary expense. Finally, it is not enough to know what to do and when to do it. In addition he must be a good manager so that other activities will not prevent his doing the necessary work at the right time.

INSECTS INJURIOUS TO CORN[4]

Corn is the favored food of many insect pests. More than 350 different species are known to attack corn, and of this number over 160 are particularly injurious. This most destructive group includes such well-known pests as the corn ear worm, European corn borer, grasshoppers, cutworms, rootworms, army worms, sugarcane borer, grain weevils, various kinds of aphids, white grubs, and many other kinds of beetles, bugs, and borers. The insects that may be con-

[4] Prepared by W. H. Larrimer, principal entomologist in charge, Division of Cereal and Forage Insects, Bureau of Entomology, U.S. Department of Agriculture.

sidered of special interest in corn production are discussed briefly in the following paragraphs.

The corn ear worm is familiar to every corn grower, and the damage it does is of such general and common occurrence that it is accepted as more or less necessary. The injury is caused entirely by the worms, or larvae of the insect; and while considerable damage is done to the unfolding leaves, the tassel, and the fresh silks of corn, the principal injury is to the tips of the ears. Damage by the corn ear worm may be kept at a minimum by growing a variety of corn that is suited to local conditions and has a long, tight husk. The general level of infestation may be reduced by plowing after the corn is cut to kill the overwintering form of the insect in the soil.

The European corn borer entered the United States about 1909 or 1910 in shipments of broomcorn from southern Europe. It was discovered in the summer of 1917 near Boston, Mass., and soon afterwards near Schenectady and Buffalo, N.Y., and near St. Thomas, Ontario. It has since spread from these original infestations until, at the close of 1932, it was known to occur throughout most of the New England States, New York, Pennsylvania, New Jersey, the Eastern Shore of Maryland and Virginia, Ohio, Michigan, and the northeastern half of Indiana, with isolated infestations in northern West Virginia and northern Kentucky. The chief methods of control consist in the utilization or destruction of all parts of the corn plant before May 15 by any one or a combination of the following methods: Feeding, burning, or plowing under cleanly.

Grasshoppers should never be allowed to get into the cornfield. Moderately careful observation will detect a threatening infestation of grasshoppers before the young hoppers leave their hatching grounds, principally along fence rows and headlands. Poisoned-bran bait applied to these areas while the young hoppers are still on their hatching grounds or, at the very latest, as soon as they begin to migrate, has been proved to be a very effective and economical control for these destructive insects.

Cutworms are the caterpillar stages of night-flying moths. These moths lay their eggs on plants or other objects, or directly on the ground, and the eggs hatch the cutworms. Many kinds of cutworms go through the winter in the soil and begin work early in the spring, such work being done ordinarily at night or on dark, cloudy days. Control can usually be obtained by the application of poisoned-bran bait, very much the same as for grasshoppers.

The southern corn rootworm in the larval stage feeds on the roots of corn or, in the case of young plants, drills a small hole into the stem just above the first circle of roots, killing the bud. Such plants either die outright or are so badly stunted as to be unproductive. Clean culture and crop rotation will largely prevent injury from this pest if the system of farming is such as to permit these practices.

Because of the great number of insect pests attacking corn and the diversity of habit of these various pests, no general recommendation can be depended upon to be universally effective as a control. In general, communities in which the farms are well managed, with clean, well-cultivated, fertile fields, clean fence rows, and crops intelligently rotated and grown from seed of adapted varieties have the least trouble with insect problems. In the event that specific infor-

mation is desired on any particular insect, specimens of the insect causing the damage, together with a sample of the injured plant, should be sent either to the State agricultural experiment station or to the Bureau of Entomology, United States Department of Agriculture, Washington, D.C.

DISEASES OF CORN

Corn, in common with most crop plants, is subject to many diseases. Some of these are largely local in their distribution or importance, whereas others are more widespread. The discussion here is limited to the two most important diseases and treats them only briefly. Bulletins containing more complete information about these and other corn diseases may be had from the United States Department of Agriculture and the various State agricultural experiment stations.

Corn smut probably is the most common disease of corn in the United States. The galls incident to this disease develop on any of the aboveground parts of the plant and may become several inches in diameter. In the earlier stages they are white or gray, later becoming black. When mature they rupture, releasing the dense powdery mass of black spores inside.

Infections with corn smut do not come from the seed, and there is no way of controlling the disease. Adapted varieties in general tend to be more resistant than unadapted sorts, but no highly resistant varieties so far are available. Inbred strains that are highly resistant to smut and that offer much promise as a basis for producing highly resistant varieties or hybrids within a few years have been isolated in the corn-breeding programs of the United States Department of Agriculture and some of the State agricultural experiment stations.

The rot diseases of the roots, stalks, and ears of corn are caused by a number of different fungi and are widely distributed but are of far more importance in some sections than others as regards both occurrence and damage.

The symptoms differ, depending upon the particular fungi involved. In general, as the name suggests, they comprise a rotting of one or more parts of the corn plant and cause loss either directly, as of ears rendered unfit for use, or indirectly by interfering with plant development and consequent yield and quality.

The organisms responsible for this group of diseases may live over in the field or be carried on the seed. Field infection may be reduced by suitable crop rotation. Careful selection and testing of seed from plants not showing symptoms of rots will aid in avoiding infection from this source. Maintaining an adequately balanced condition of soil fertility helps in the control of the rot diseases. Seed treatment with the newer mercury-compound dusts also is warranted in areas where these diseases are an important factor. In some localities, however, seed treatment has not increased the yield, and under such conditions it is an unnecessary expense. The ultimate control of these diseases lies in the breeding of resistant sorts, which is under way in the States where the diseases are important.

U.S. GOVERNMENT PRINTING OFFICE: 1933

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